

**2019 Multiscale Modeling Consortium Meeting - Translation and Dissemination (March 6-7, 2019)**

***Poster Abstract Submission Form***

**PI(s) of MSM U01:** Bela Suki and Jason Bates

**Institution(s):** Boston University and University of Vermont

**MSM U01 Grant Number:** U01HL139466

**Title of Grant:** A multi-scale computational model of the extracellular matrix of the lung

**Abstract Authors**

Dylan Casey, Jake Herrmann, Samer Bou Jawde, Bela Suki, Jason Bates

**Abstract Text**

There is considerable current interest in modeling the mechanical properties of the extracellular matrix (ECM) of the lung since it influences mechanical behavior over multiple length scales from the alveolar wall to the whole organ. The ECM is comprised of glycosaminoglycans and fibrous proteins, with the most pertinent fibers being flexible elastin and loadbearing collagen. A mesh-like network of ECM surrounding the alveoli supports and separates the pulmonary capillaries from the alveolar epithelium. In interstitial lung diseases such as fibrosis, increased collagen deposition and crosslinking modifies this structure substantially, causing loss of function and an increase in the nonlinear stress-strain behavior of the alveolar parenchyma. Understanding the precise link between ECM structure and function is thus crucial for understanding how disease progression is linked to symptoms. However, attempts to simulate this behavior numerically have not thus far accounted for the random organization of the ECM, collagen-elastin interactions, and crosslinking. The goal of this work was to establish such a model of an alveolar wall using a random network of Hookean springs.

Lines with random slopes and initial positions were laid over a square. At a percentage of intersections determined by the degree of crosslinking, two lines were joined and split into four. All the lines were randomly distributed at a physiologically appropriate ratio to represent collagen and elastin. These fibers were given stress-free lengths in proportion to their initially defined lengths, and spring constants inversely proportional to their lengths. Springs representing collagen springs were two orders of magnitude higher in stiffness than the springs representing elastin. The equilibrium state of the entire network was determined iteratively using Newton's method at each step during incremental uniaxial stretch. The vector force on the boundary in the direction of stretch was determined as a function of stretch ratio, and mirrored experimental findings in normal and aged lung tissue strips. We anticipate using this model to represent the alveolar wall in a multi-scale model of alveolar parenchyma.